Capacitance Resistance Model = CRM

Specific type of Production Analysis (PA) workflow based on correlation between injection rates history and production rate history with account of bottomhole pressure history.

In case the bottomhole pressure data is not available it is considered constant over time.

Motivation

Production rate in producing well depends on its productivity index J, current formation pressure p_e and current BHP p_{wf}:

(1) $$q_1^{\uparrow}(t) = J \cdot \left(p_e(t) - p_{wf}(t)\right)$$

and as such depends on completion/lift settings (defining $p_{wf}(t)$) and how formation pressure is maintained $p_e = p_e(t)$ over time.

It keeps declining due to the offtakes:

(2) $$p_e(t) = p_e[q_1^{\uparrow}(t), q_2^{\uparrow}(t), q_3^{\uparrow}(t), \ldots]$$

and maintained by either aquifer or Fluid Injection and in the latter case depends on injection rates:

(3) $$p_e(t) = p_e[q_1^{\downarrow}(t), q_2^{\downarrow}(t), q_3^{\downarrow}(t), \ldots]$$

The combination of (1), (2) and (3) lead to the correlation between production rates, injection rates and bottomhole pressure variation.

The ultimate purpose of CRM is to correlate the long-term (few months or longer) injection rates history with production rates history and BHP history (recorded by PDG).

It is essentially based on the fact that production rate responds to changes in BHP and offset injection.

The major assumptions in CRM model are:

- productivity index of producer stays constant in time
- dynamic drainage volume of producer is finite and constant in time (which is equivalent to PSS flow regime)
- total compressibility within the drainage volume of a given producer stays constant in time

Assumption 2 means that interference between producers is fairly constant in time despite the rate variations and their impact on the dynamic drainage volumes.

Goals	Objectives

Identify and prioritise production optimisation opportunities	Generate production and formation pressure forecasts based on the bottom-hole pressure and injection rates
Identify and prioritise redevelopment opportunities	Assess productivity index of producing wells
Identify and prioritise surveillance candidates	Assess dynamic drainage volume around producing wells
	Quantify connectivity between injectors and producers
	Assess water flood efficiency against expectations and / or between wells or well groups
Advantages	

	Limitations
Fast-track	It only models injector-producer system
Requires minimum input data (BHP history, fowrate history and FVF)	Requires eventful history of injection rates variations
Robust procedure (no manual setups)	Requires productivity index of producers to stay constant
Does not involve full-field 3D dynamic modelling and associated assumptions	Requires the drainage volumes of all producers stay the same throughout the modelling period
	Only applicable for specific subset of PSS fluid flow regimes

Technology

The CRM trains linear correlation between variation of production rates against variation of injection rates with account of bottom-hole pressure history records in producers.

See Capacitance-Resistivity Model @model

Inputs	**Outputs**
Production rate history	Productivity Index for the focus producer
Bottom-hole pressure history	Drainage volume by the focus produce producer

Injection rate history	Share of injection going towards the focus producer
PVT model	

See Also

Petroleum Industry / Upstream / Production / Subsurface Production / Field Study & Modelling / Production Analysis

[Capacitance-Resistivity Model @model]

References

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